

12-Bit, 10MHz, Low-Power Sampling A/D Converters

FEATURES

- 12-bit resolution
- 10MHz minimum sampling rate
- Functionally complete
- Small 24-pin DDIP or SMT package
- Requires only $\pm 5V$ supplies
- Low-power, 1.8 Watts
- Outstanding dynamic performance
- Edge-triggered
- No missing codes over temperature
- Ideal for both time and frequency-domain applications



GENERAL DESCRIPTION

The ADS-119 is a high-performance, 12-bit, 10MHz sampling A/D converter. The device samples input signals up to Nyquist frequencies with no missing codes. The ADS-119 features excellent dynamic performance including a typical SNR of 69dB.

Packaged in a metal-sealed, ceramic, 24-pin DDIP, the functionally complete ADS-119 contains a fast-settling sample/hold amplifier, a subranging (two-pass) A/D converter, a precise voltage reference, timing/control logic, and error-correction circuitry. All timing and control logic operates from the rising edge of a single start convert pulse. Digital input and output levels are TTL.

Requiring only $\pm 5V$ supplies, the ADS-119 typically dissipates 1.8 Watts. The unit offers a bipolar input range of $\pm 1.5V$. Models are available for use in either commercial (0 to $+70^{\circ}C$) or military (-55 to $+125^{\circ}C$) operating temperature ranges.

INPUT/OUTPUT CONNECTIONS

PIN	FUNCTION	PIN	FUNCTION
1	BIT 12 (LSB)	24	NO CONNECT
2	BIT 11	23	ANALOG GROUND
3	BIT 10	22	NO CONNECT
4	BIT 9	21	+5V ANALOG SUPPLY
5	BIT 8	20	-5V SUPPLY
6	BIT 7	19	ANALOG INPUT
7	BIT 6	18	ANALOG GROUND
8	BIT 5	17	OFFSET ADJUST
9	BIT 4	16	START CONVERT
10	BIT 3	15	DATA VALID
11	BIT 2	14	DIGITAL GROUND
12	BIT 1	13	+5V DIGITAL SUPPLY

Typical applications include signal analysis, medical/graphic imaging, process control, ATE, radar, and sonar.

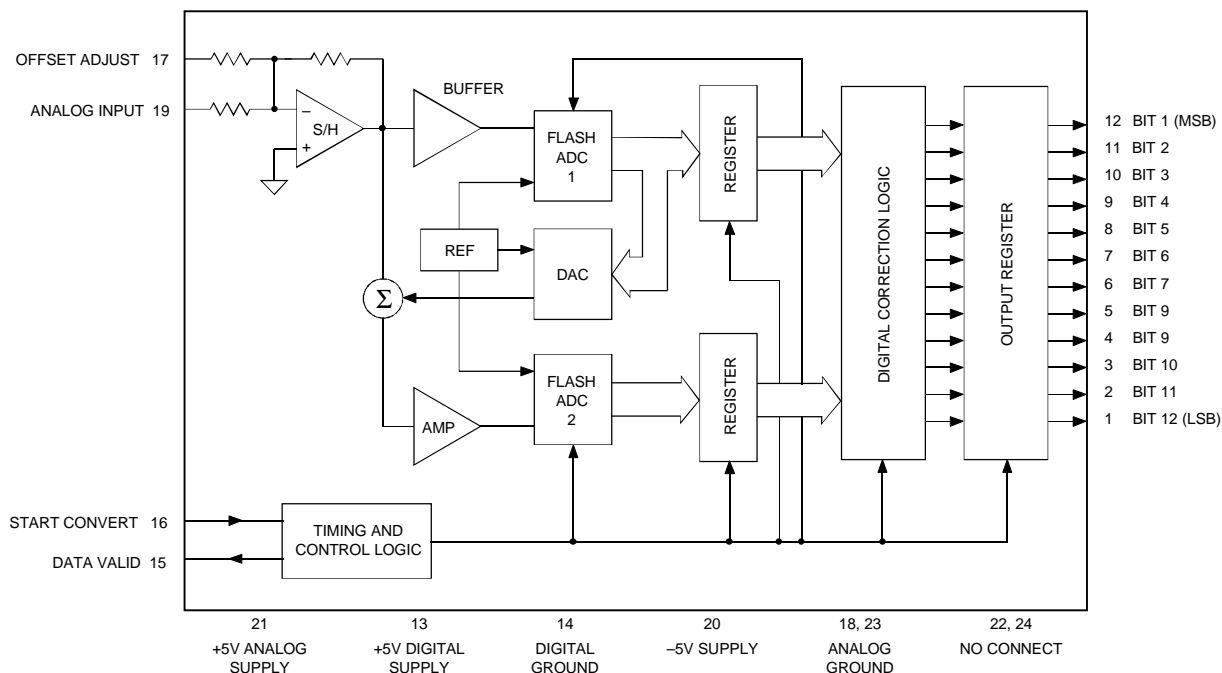


Figure 1. ADS-119 Functional Block Diagram

ABSOLUTE MAXIMUM RATINGS

PARAMETERS	LIMITS	UNITS
+5V Supply (Pin 13, 21)	0 to +6	Volts
–5V Supply (Pin 20)	0 to –6	Volts
Digital Input (Pin 16)	–0.3 to +V _{DD} +0.3	Volts
Analog Input (Pin 19)	±5	Volts
Lead Temp (10 seconds)	+300	°C

FUNCTIONAL SPECIFICATIONS

(T_A = +25°C, ±V_{DD} = ±5V, 10MHz sampling rate, and a minimum 3 minute warmup ① unless otherwise specified.)

PHYSICAL/ENVIRONMENTAL

PARAMETERS	MIN.	TYP.	MAX.	UNITS
Operating Temp. Range, Case	0	—	+70	°C
ADS-119MC/GC	–55	—	+125	°C
ADS-119MM/GM/883				
Thermal Impedance		6		°C/Watt
θ _{JC}		24		°C/Watt
θ _{CA}				
Storage Temperature	–65	—	+150	°C
Package Type	24-pin, metal-sealed, ceramic DDIP or SMIT			
Weight	0.42 ounces (12 grams)			

PARAMETERS	+25°C			0 to +70°C			–55 to +125°C			UNITS
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
ANALOG INPUT										
Input Voltage Range ②	—	±1.5	—	—	±1.5	—	—	±1.5	—	Volts
Input Resistance	300	350	—	300	350	—	300	350	—	Ω
Input Capacitance	—	6	15	—	6	15	—	6	15	pF
DIGITAL INPUT										
Logic Levels										
Logic "1"	+2.0	—	—	+2.0	—	—	+2.0	—	—	Volts
Logic "0"	—	—	+0.8	—	—	+0.8	—	—	+0.8	Volts
Logic Loading "1"	—	—	+20	—	—	+20	—	—	+20	μA
Logic Loading "0"	—	—	–20	—	—	–20	—	—	–20	μA
Start Convert Positive Pulse Width ③	—	50	—	—	50	—	—	50	—	ns
STATIC PERFORMANCE										
Resolution	—	12	—	—	12	—	—	12	—	Bits
Integral Nonlinearity (f _{IN} = 10kHz)	—	±0.75	—	—	±1.0	—	—	±1.5	—	LSB
Differential Nonlinearity (f _{IN} = 10kHz)	—	±0.5	±0.95	0.95	±0.5	+1	–0.95	±0.75	+1.25	LSB
Full Scale Absolute Accuracy	—	±0.2	±0.5	—	±0.5	±0.75	—	±0.75	±1.5	%FSR
Bipolar Zero Error (Tech Note 2)	—	±0.2	±0.6	—	±0.3	±0.7	—	±0.6	±1.0	
Unipolar Offset Error (Tech Note 2)	—	±0.1	±0.6	—	±0.3	±0.7	—	±0.7	±1.5	%FSR
Gain Error (Tech Note 2)	—	±0.1	±0.5	—	±0.5	±1.0	—	±1.0	±2.5	%
No Missing Codes (f _{IN} = 10kHz)	12	—	—	12	—	—	12	—	—	Bits
DYNAMIC PERFORMANCE										
Peak Harmonics (–0.5dB)										
dc to 1MHz	—	–70	–63	—	–70	–63	—	–69	–61	dB
1MHz to 2.5MHz	—	–70	–63	—	–70	–63	—	–69	–60	dB
2.5MHz to 5MHz	—	–70	–63	—	–70	–63	—	–67	–60	dB
Total Harmonic Distortion (–0.5dB)										
dc to 1MHz	—	–69	–63	—	–69	–63	—	–68	–60	dB
1MHz to 2.5MHz	—	–68	–63	—	–68	–63	—	–67	–60	dB
2.5MHz to 5MHz	—	–68	–63	—	–67	–63	—	–66	–60	dB
Signal-to-Noise Ratio										
(w/o distortion, –0.5dB)										
dc to 1MHz	66	69	—	66	69	—	63	67	—	dB
1MHz to 2.5MHz	66	69	—	66	69	—	63	66	—	dB
2.5MHz to 5MHz	66	69	—	66	69	—	63	66	—	dB
Signal-to-Noise Ratio ④										
(& distortion, –0.5dB)										
dc to 1MHz	62	66	—	62	66	—	60	65	—	dB
1MHz to 2.5MHz	62	66	—	62	66	—	60	65	—	dB
2.5MHz to 5MHz	62	66	—	62	66	—	60	64	—	dB
Two-tone Intermodulation										
Distortion (f _{IN} = 100kHz, 240kHz, f _S = 1MHz, –0.5dB)	—	–72	—	—	–72	—	—	–72	—	dB
Noise	—	250	—	—	300	—	—	400	—	μVrms
Input Bandwidth (–3dB)										
Small Signal (–20dB input)	—	60	—	—	60	—	—	60	—	MHz
Large Signal (–0dB input)	—	10	—	—	10	—	—	10	—	MHz
Feedthrough Rejection (f _{IN} = 5MHz)	—	76	—	—	76	—	—	76	—	dB
Slew Rate	—	±400	—	—	±400	—	—	±400	—	V/μs
Aperture Delay Time	—	5	—	—	5	—	—	5	—	ns
Aperture Uncertainty	—	3	—	—	3	—	—	3	—	ps rms
S/H Acquisition Time										
(to ±0.01%FSR, 3V step)	30	35	37	30	35	37	30	35	37	ns
Overvoltage Recovery Time ⑤	—	100	—	—	100	—	—	100	—	ns
A/D Conversion Rate	10	—	—	500	—	—	500	—	—	MHz

	+25°C			0 to +70°C			-55 to +125°C			
DIGITAL OUTPUTS	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS
Logic Levels										
Logic "1"	+2.4	—	—	+2.4	—	—	+2.4	—	—	Volts
Logic "0"	—	—	+0.4	—	—	+0.4	—	—	+0.4	Volts
Logic Loading "1"	—	—	-4	—	—	-4	—	—	-4	mA
Logic Loading "0"	—	—	+4	—	—	+4	—	—	+4	mA
Output Coding	Offset Binary									
POWER REQUIREMENTS										
Power Supply Ranges ⑥										
+5V Supply	+4.75	+5.0	+5.25	+4.75	+5.0	+5.25	+4.9	+5.0	+5.25	Volts
-5V Supply	-4.75	-5.0	-5.25	-4.75	-5.0	-5.25	-4.9	-5.0	-5.25	Volts
Power Supply Current										
+5V Supply	—	+200	+215	—	+200	+215	—	+200	+215	mA
-5V Supply	—	-180	-205	—	-180	-205	—	-180	-205	mA
Power Dissipation	—	1.8	2.1	—	1.8	2.1	—	1.8	2.1	Watts
Power Supply Rejection	—	—	±0.01	—	—	±0.01	—	—	±0.01	%FSR/%V

Footnotes:

① All power supplies must be on before applying a start convert pulse. All supplies and the clock (START CONVERT) must be present during warmup periods. The device must be continuously converting during this time. There is slight degradation in performance when using ±12V supplies.

② See ordering information for availability of ±5V input range. Contact DATEL for availability of other input voltage ranges.

③ A 200ns wide start convert pulse is used for all production testing. Only the rising edge of the start convert pulse is required for the device to operate (edge-triggered).

④ Effective bits is equal to:

(SNR + Distortion) – 1.76 +

20 log

Full Scale Amplitude

Actual Input Amplitude

6.02

⑤ This is the time required before the A/D output data is valid after the analog input is back within the specified range.

TECHNICAL NOTES

1. Obtaining fully specified performance from the ADS-119 requires careful attention to pc-card layout and power supply decoupling. The device's analog and digital ground systems are connected to each other internally. For optimal performance, tie all ground pins (14, 18, and 23) directly to a large analog ground plane beneath the package.

Bypass all power supplies to ground with 4.7µF tantalum capacitors in parallel with 0.1µF ceramic capacitors. Locate the bypass capacitors as close to the unit as possible.

2. The ADS-119 achieves its specified accuracies without the need for external calibration. If required, the device's small

initial offset and gain errors can be reduced to zero using the adjustment circuitry shown in Figures 3 and 4. For operation without adjustment, tie pin 17 to analog ground. When using this circuitry, or any similar offset and gain-calibration hardware, make adjustments following warmup. To avoid interaction, always adjust offset before gain.

3. Applying a start convert pulse while a conversion is in progress (EOC = logic "1") will initiate a new and inaccurate conversion cycle.
4. Data is valid only for the time period (55ns, typical) shown in Figure 2 even if the device is sampling at less than 10MHz.

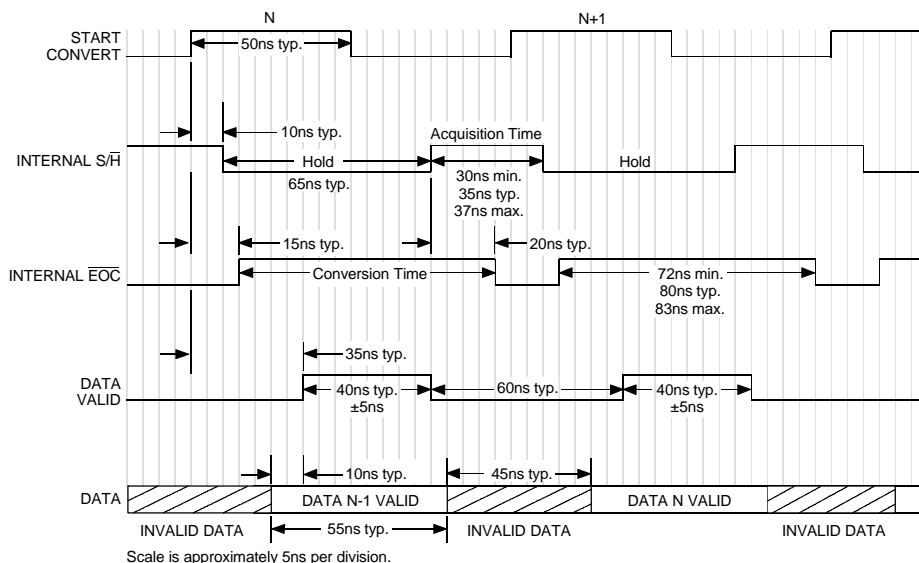


Figure 2. ADS-119 Timing Diagram

CALIBRATION PROCEDURE

(Refer to Figures 3 and 4, Table 1)

Any offset and/or gain calibration procedures should not be implemented until devices are fully warmed up. To avoid interaction, offset must be adjusted before gain. The ranges of adjustment for the circuits in Figure 3 and 4 are guaranteed to compensate for the ADS-119's initial accuracy errors and may not be able to compensate for additional system errors.

A/D converters are calibrated by positioning their digital outputs exactly on the transition point between two adjacent digital output codes. This can be accomplished by connecting LED's to the digital outputs and adjusting until certain LED's "flicker" equally between on and off. Other approaches employ digital comparators or microcontrollers to detect when the outputs change from one code to the next.

Offset adjusting for the ADS-119 is normally accomplished at the point where the MSB is a 1 and all other output bits are 0's and the LSB just changes from a 0 to a 1. This digital output transition ideally occurs when the applied analog input is $\pm \frac{1}{2}$ LSB ($\pm 366\mu\text{V}$).

Gain adjusting is accomplished when all bits are 1's and the LSB just changes from a 1 to a 0. This transition ideally occurs when the analog input is at +full scale minus $1 \frac{1}{2}$ LSB's ($+1.4989\text{V}$).

Zero/Offset Adjust Procedure

1. Apply a train of pulses to the START CONVERT input (pin 16) so the converter is continuously converting.
2. Apply $+366\mu\text{V}$ to the ANALOG INPUT (pin 19).
3. Adjust the offset potentiometer until the output bits are 1000 0000 0000 and the LSB flickers between 0 and 1.

Gain Adjust Procedure

1. Apply $+1.4989\text{V}$ to the ANALOG INPUT (pin 19).
2. Adjust the gain potentiometer until all output bits are 1's and the LSB flickers between 1 and 0.
3. To confirm proper operation of the device, vary the input signal to obtain the output coding listed in Table 1.

Table 1. Output Coding for Bipolar Operation

BIPOLAR SCALE	ADS-119 INPUT VOLTAGE ($\pm 1.5\text{V}$ RANGE)	OUTPUT CODING	
		MSB	LSB
+FS-1 LSB	+1.49927V	1111 1111	1111
+3/4 FS	+1.12500V	1110 0000	0000
+1/2 FS	+0.75000V	1100 0000	0000
0	0.00000V	1000 0000	0000
-1/2 FS	-0.75000V	0100 0000	0000
-3/4 FS	-1.12500V	0010 0000	0000
-FS +1 LSB	-1.49927V	0000 0000	0001
-FS	-1.50000V	0000 0000	0000

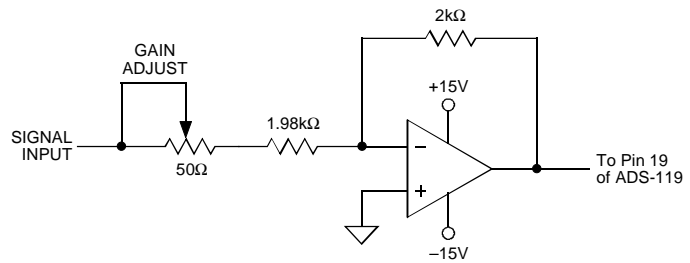
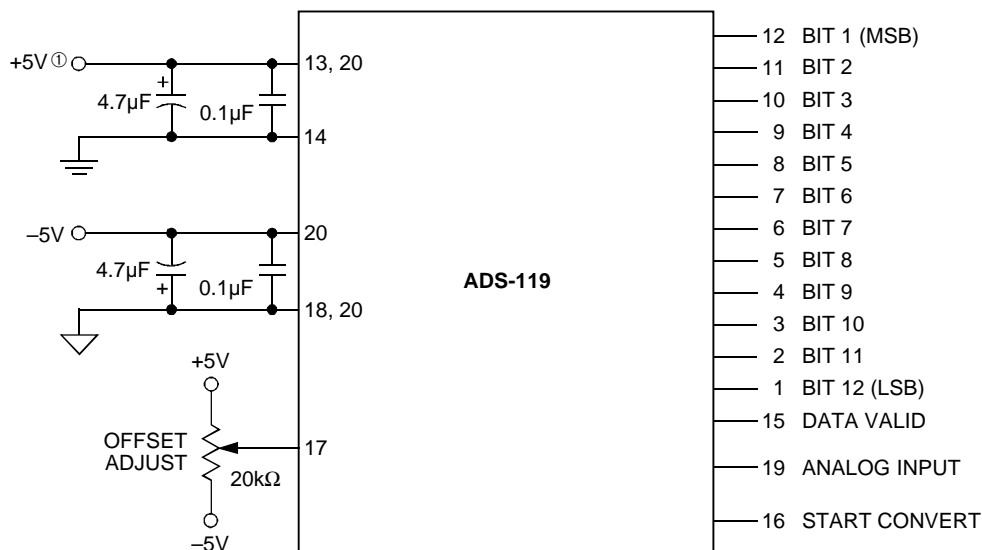


Figure 3. Optional Calibration Circuit, ADS-119



① A single +5V supply should be used for both the +5V analog and +5V digital. If separate supplies are used, the difference between the two cannot exceed 100mV.

Figure 4. Typical Connection Diagram



THERMAL REQUIREMENTS

All DATEL sampling A/D converters are fully characterized and specified over operating temperature (case) ranges of 0 to +70°C and -55 to +125°C. All room-temperature ($T_A = +25^\circ\text{C}$) production testing is performed without the use of heat sinks or forced-air cooling. Thermal impedance figures for each device are listed in their respective specification tables.

These devices do not normally require heat sinks, however, standard precautionary design and layout procedures should be used to ensure devices do not overheat. The ground and power planes beneath the package, as well as all pcb signal runs to and from the device, should be as heavy as possible to help conduct heat away from the package. Electrically-insulating, thermally-conductive "pads" may be installed underneath the package. Devices should be soldered to boards rather than "socketed", and of course, minimal air flow over the surface can greatly help reduce the package temperature.

In more severe ambient conditions, the package/junction temperature of a given device can be reduced dramatically (typically 35%) by using one of DATEL's HS Series heat sinks. See Ordering Information for the assigned part number. See page 1-183 of the DATEL Data Acquisition Components Catalog for more information on the HS Series. Request DATEL Application Note AN-8, "Heat Sinks for DIP Data Converters", or contact DATEL directly, for additional information.

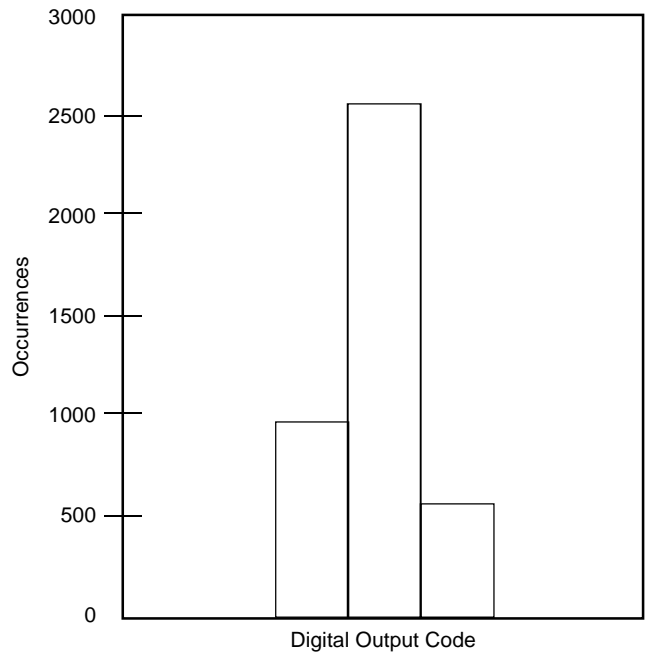


Figure 6. ADS-119 Grounded Input Histogram

This histogram represents the typical peak-to-peak noise (including quantization noise) associated with the ADS-119. 4,096 conversions were processed with the input to the ADS-119 tied to analog ground.

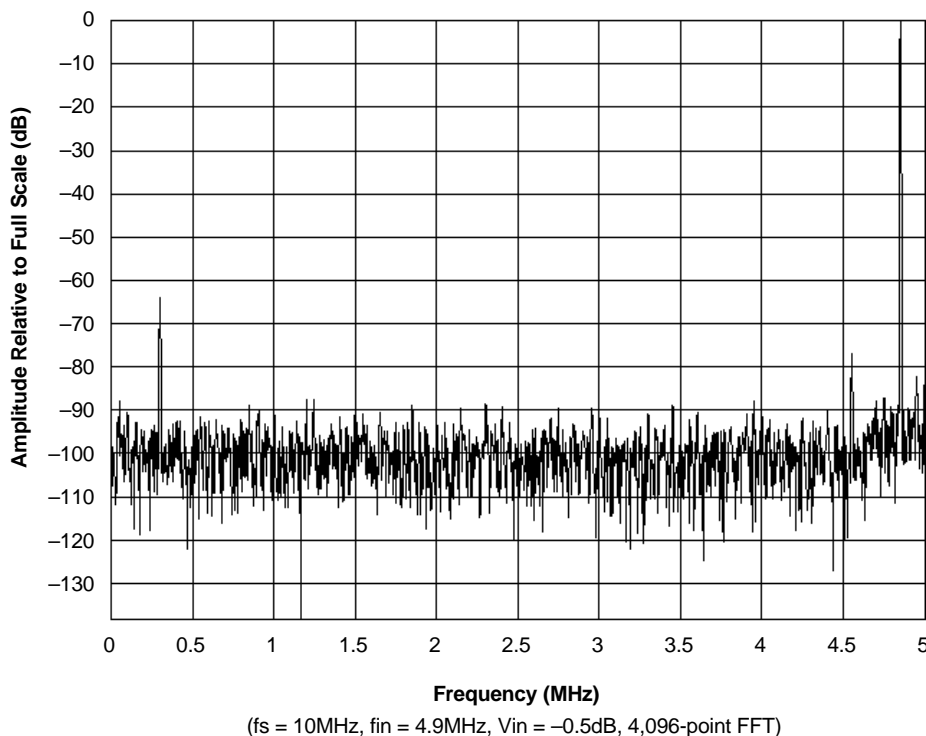


Figure 7. ADS-119 FFT Analysis

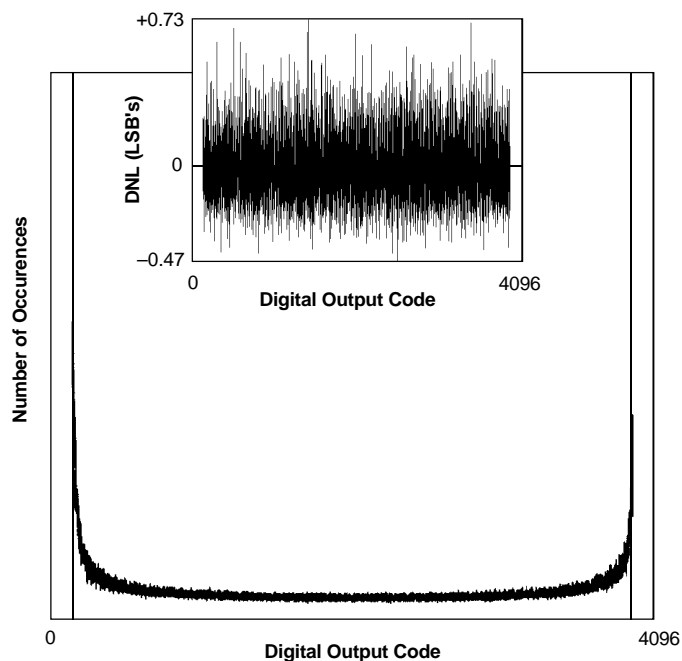


Figure 8. ADS-119 Histogram and Differential Nonlinearity

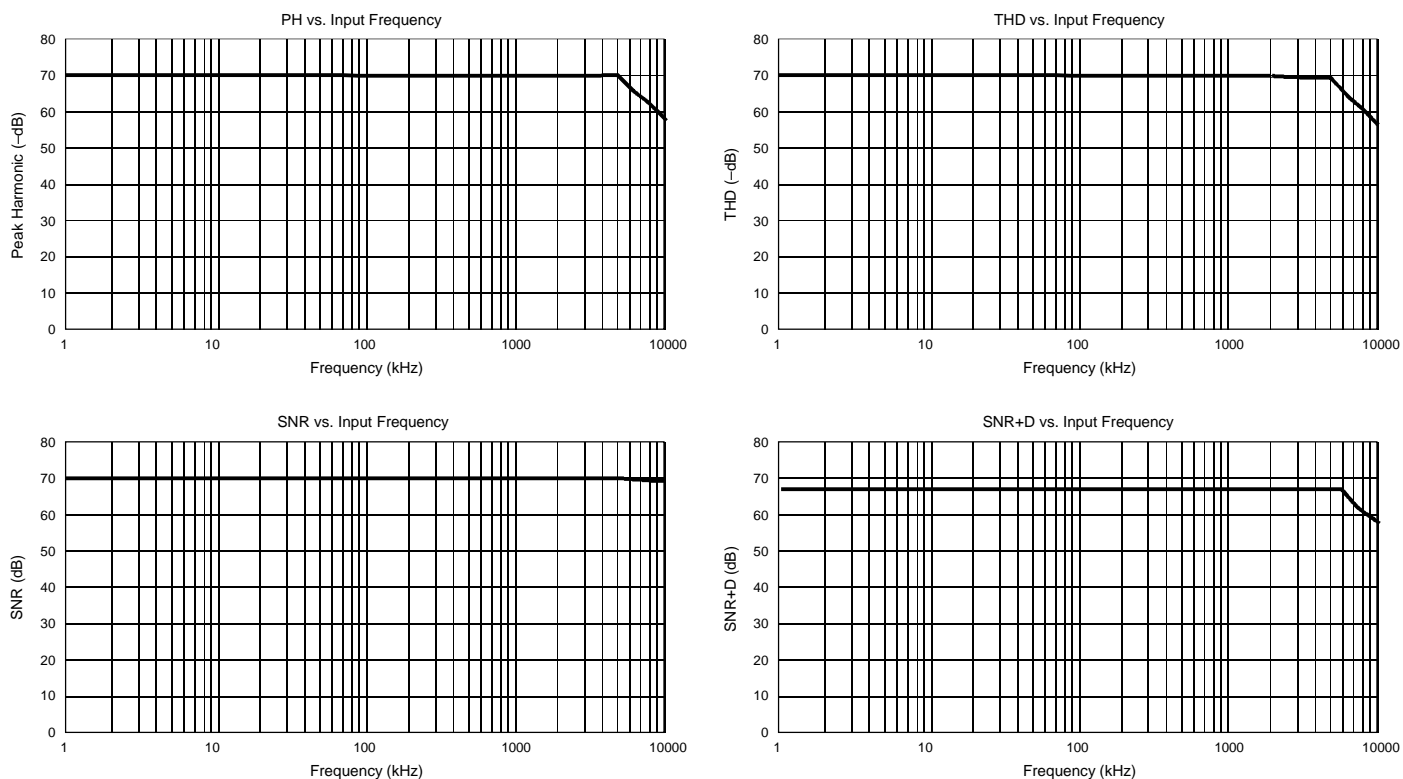
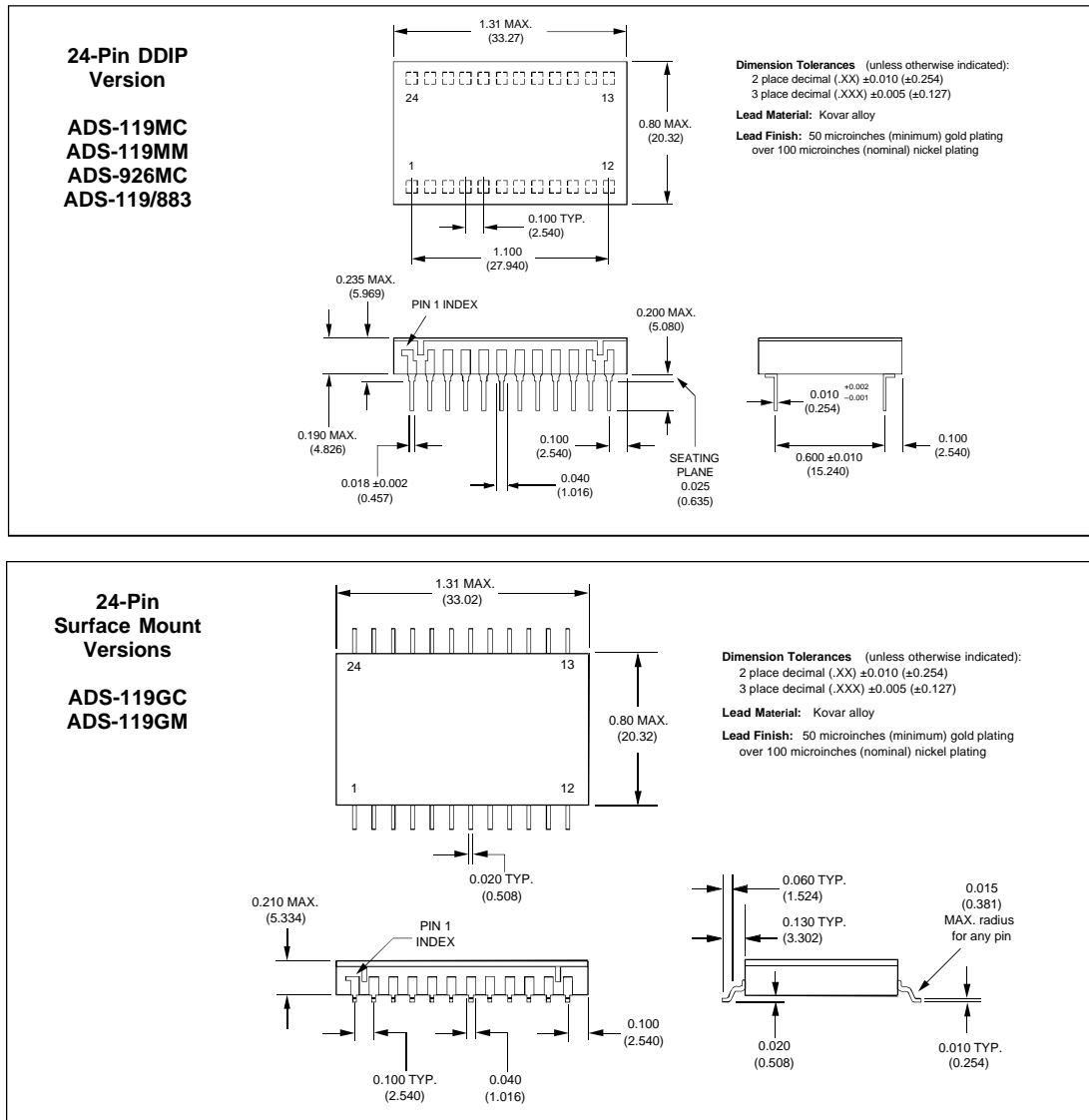


Figure 9. ADS-119 Performance Curves

MECHANICAL DIMENSIONS INCHES (mm)



ORDERING INFORMATION

MODEL NUMBER	OPERATING TEMP. RANGE	ACCESSORIES
ADS-119MC	0 to +70°C	ADS-B119 Evaluation Board (without ADS-119)
ADS-119MM	-55 to +125°C	HS-24 Heat Sinks for all ADS-119 DDIP models
ADS-119/883	-55 to +125°C	
ADS-119GC	0 to +70°C	
ADS-119GM	-55 to +125°C	

Receptacles for PC board mounting can be ordered through AMP Inc. Part # 3-331272-8 (Components Lead Socket), 24 required.
For MIL-STD-883 product specification or availability of surface mounts package, contact DATEL.